



Discussion Paper

Make Better Wildland Fire Management Decisions using Behavioural Science

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A Growing Challenge

One of the primary responsibilities of a wildland fire manager is to make decisions under difficult circumstances. Sound decision-making can be the difference between success and catastrophe. Wildfires and response operations are dynamic, uncertain, and time sensitive. In this environment, fire managers must make situational assessments with incomplete and at times conflicting information. They rely on the expertise and intuition honed over their career to identify options and develop strategies and tactics.

That ability is being strained. Wildland fire decision-makers are managing greater complexity with fewer years of experience. Conditions in the fire environment are more extreme but managers often have less expertise to draw on. How can decisions be improved under these conditions?

Behavioural science is an emerging discipline that draws on psychology and economics to study how people act under uncertainty. Its findings are transforming how professionals make high consequence decisions in comparable fields. In this paper, we introduce how behavioural science can help wildland fire managers build expertise and improve decisions.

Decision-making under Uncertainty

Uncertainty is essentially incomplete information, which is common in everyday life. People constantly make predictions with limited information – will it rain today; is a stranger trustworthy; who will win an election, and so on. Psychologists have found that we use unconscious mental shortcuts, or heuristics, to reach quick judgements. Heuristics are helpful in many situations but can also lead to systematic errors. When heuristics predictably sway decisions in one direction or another, errors are called cognitive biases.

We are all subject to heuristics and cognitive biases, but they are usually invisible to us. We actively seek information that supports our theories (confirmation bias). We estimate the likelihood of events by how easily examples come to mind (availability heuristic). Each helps us navigate a complex world but can also lead us astray.

A given decision may be influenced by multiple cognitive biases simultaneously. For example: when considering a new project, people tend to be overly optimistic about the chances of success (called planning fallacy), but overly sensitive to the possibility of negative outcomes (loss aversion). The push and pull of various biases can balance each other out or exacerbate their impact.

Behavioural science provides a structure for improving judgement by accounting for these patterns of behaviour. Results can be dramatic. The Organisation for Economic Development and Cooperation called behavioural science a “paradigm shift” being applied “around the world and across a wide range of sectors and policy areas”¹. It is used widely in medicine, finance, and the military. In one notable example, a group of amateur enthusiasts used behavioural science tools to decisively outperform national intelligence agents in predicting real-world events.

Wildland Fire Decisions

Wildland fire managers bring experience and expertise in a range of disciplines: ecosystem processes, fire behaviour, operational logistics, communications, and more. Their judgements tend to be most reliable on tasks where the results of their decisions are immediately clear.

As complexity and ambiguity grows, so does the influence of cognitive patterns. When decision-makers must weigh many conflicting cues, the environment provides irregular feedback, or decisions are unstructured, cognitive biases present a problem. Many domains of wildland fire management fit this description, including risk mitigation, response strategy, evacuations, and so on.

Studies have found a range of cognitive biases at play in wildland fire management. They lead decision-makers to systematically overlook risks, overestimate chances of success, and select strategies that are less likely to be effective. The takeaway is not that decisions are imperfect, rather it is that they can be improved, and relatively simply. Approaches that increase the quality of decisions are inexpensive, straightforward, and worthy of greater attention from wildland fire management agencies.

Which tools to use depends on context. Behavioural science approaches fall into three broad categories, those that: i) de-bias errors, ii) create robust decision processes, and iii) build expertise. We present six approaches relevant to wildland fire here.

¹ Behavioural Insights and Public Policy: Lessons from Around the World (OECD, 2015)

De-biasing

1

Take the Outside View

Consider the planning fallacy. A Plans Section Chief may carefully and confidently devise a strategy that accounts for rates of fireline construction, weather forecasts, and terrain difficulties. They can work out optimal logistics and the reasons their strategy will succeed. Behavioural scientists call this taking an 'inside view' of operations, which often leads to excessive optimism. It is best complemented with an outside view — one that considers the track record of similar tasks. In practice, Incident Management Teams tend to estimate a strategy's probability of success near 80 – 90% when observed rates are in the range of 30 – 40%.

Teams and individuals can improve their judgements by starting from the outside view and adjusting. When considering a new strategy or task, recall similar operations in the past. How often were they successful? Is this task easier or harder than those? The assessment reached by an anchor-and-adjust process will be far more accurate.

2

Conduct a Premortem

A related method for improved operational planning is the 'premortem', which imagines that a plan has failed and asks for reasons. An Operations Section meeting might include a brief session, such as: "Let's assume it's the end of our team's shift and we failed to contain the fire. Why has that happened?" Premortems encourage a more realistic risk assessment, help with contingency plans, and highlight factors that will lead to improved chances of success.

3

Train Decision Skills

High-level decision training is remarkably effective in improving complex judgement. Reasoning and probability skills increase decision accuracy. A recent study showed that as little as one hour of training can improve judgement accuracy by 14%, even over a year later. Training content includes statistical patterns and applied skills like how to update judgements when new information is received and weigh evidence that challenges our conclusions.

4

Nudge

Choice architecture, or 'nudges', make small changes to a decision environment that remove barriers to good decision-making, often by adjusting how information or options are presented. Common approaches include smart default options, information ordering, social norms, and commitment devices.

For instance, wildfire managers may be dissuaded from promising strategies due to unrelated administrative factors -- delayed approvals or arduous paperwork. A choice architecture approach could look to streamline these processes, freeing decision-makers to focus on other aspects.

Robust Decision Processes

5

Decision Hygiene

Decisions can be improved without knowing which heuristics and cognitive biases are at play through 'decision hygiene'. Decision hygiene involves techniques that reliably lead to improved decisions.

For example, evidence shows that irrelevant information, small or random factors, make major differences in professional judgement. Judges hand out harsher sentences when hungry and are more lenient after the local sports team wins. Fatigue, mood, and other random factors affect wildland fire management decisions as well. The impacts can be reduced by focusing attention on the most relevant factors during a decision. Simple decision aids such as checklists can highlight crucial information and improve decision quality.

Other decision hygiene methods are more extensive. Approaches include combining independent judgements, delaying intuition, structuring complex judgements into independent tasks, and many more.

Build Expertise

6

Provide Good Feedback

Wildland fire managers rely on experience and intuition to make quick judgements. Expert intuition is not mystical; it is unconscious pattern recognition. Developing true expertise requires a coherent environment and a lot of practice. Agencies can use behavioural science insights to improve the efficiency with which experience is translated into expertise. A key principle is feedback quality.

When making judgements under uncertainty, people benefit enormously from feedback. Weather prediction is complex, but when forecasters announce a 70% chance of rain, it rains on average about 70% of the time. Forecasters make measurable predictions and receive clear, timely results. Bridge players, internal auditors, and oil geologists perform similarly well. These disciplines have learned to improve accuracy over time.

It is less clear when judgements about wildland fire are trustworthy. Predictions and results are often ambiguous. Whether a forecast concerns wildland fire behaviour or operational activities, it is rarely specific enough to be testable. It is more useful to be 80% confident that fire will reach a point by the end of the operational period than to be fairly sure the fire will arrive soon.

More concerningly, it is not obvious when predictions are accurate. Forecasters may be required to seek out and interpret results, and accuracy is seldom tracked over time. Wherever possible, providing prompt, clear feedback through objective measures is the most effective way to translate experience into expertise. Tracking judgements, confidence levels, and results improves expert intuition over time. Where formal tracking is impractical, debriefs and decision journals can help capture feedback and build expertise.

Applying Behavioural Science

These examples are a starting point for discussions on behavioural science approaches relevant to wildland fire management. Context-specific design and implementation will be key to their success. Many approaches prompt conscious deliberation, but highly time constrained environments will benefit from reducing cognitive load and improving intuition.

Wildland fire managers have learned to rise to the challenges offered by the fire environment. They are comfortable with unstructured intuitive decisions – ‘trusting their gut’. This is particularly true of senior and experienced decision-makers. They share a sense of purpose, a desire for autonomy, and a commitment to mastery. Earning the confidence of gut-trusting wildland fire managers is crucial to the success of behavioural science applications. Decision-makers need to be meaningfully involved in design and application. Interventions can augment their expertise but cannot replace it.

New Tools for a New Era

Behavioural science offers an opportunity to reframe the current wildland fire management paradigm. Most initiatives to improve on-the-ground decisions have focused on the quality and availability of technical information. In some contexts, enhanced information has led to diminishing returns. Wildland fire managers can be subject to cognitive overload, where increasing available information and resources decreases the ability to reach good decisions.

Subjective decision factors are often underappreciated by wildland fire agencies and researchers. When psychology is considered, it tends to be in the context of the general public’s decisions. The cognitive aspects of expert decision-makers have attracted less attention. We believe that a focus on these factors can meaningfully improve wildland fire outcomes.

There is much to do. Decision interventions need to be evidence-based. Research projects with an operational focus would improve our understanding of cognitive patterns in wildland fire managers. Rigorous data would help prioritize decision environments and determine the most effective approaches. However, agencies need not wait to begin improving decision quality. Behavioural science approaches have been pioneered in disciplines of professional judgments for decades and can be rapidly adapted for wildland fire management contexts.

By any measure, wildland fire management has entered a new and more challenging era. Trade-offs between competing objectives are increasingly fraught. Decision-makers need all the advantages they can muster. By leveraging behavioural science, agencies can design decision processes that offer them the greatest opportunity for success.

Further Reading

Psychology Journal Articles

- [Judgment under Uncertainty](#). Amos Tversky, Daniel Kahneman (1974)
- [Conditions for intuitive expertise](#). Daniel Kahneman, Gary Klein (2009)
- [Timid choices and bold forecasts](#). Daniel Kahneman, Dan Lovallo (1993)
- [Rethinking the training of intelligence analysts](#). Welton Chang, Philip Tetlock (2016)

Wildland Fire Journal Articles

- [Social, institutional, and psychological factors affecting wildland fire incident decision making](#). Matthew Thompson (2014)
- [Can behavioral decision theory explain risk-averse fire management decisions?](#) Lynn Maguire, Elizabeth Albright (2005)
- [Risk preferences in strategic wildland fire decision making](#). Matthew Wibbenmeyer, Michael Hand, David Calkin, Tyon Venn, Matthew Thompson (2013)
- [The influence of incident management teams on the deployment of wildland fire suppression resources](#). Michael Hand, Hari Katuwal, David Calkin, Matthew Thompson (2017)

Books

- Superforecasting. Philip Tetlock, Dan Gardner. (2015)
- Noise. Daniel Kahneman, Olivier Sibony, Cass Sunstein. (2021)
- Thinking, Fast and Slow. Daniel Kahneman. (2011)
- Nudge. Richard Thaler, Cass Sunstein. (2008)

Authors

The authors have drawn on their extensive experience in wildland fire management and operational research for this discussion paper.

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Jonathan Reimer is a senior fire and emergency manager based in British Columbia, Canada. He was Director of the Provincial Emergency Coordination Centre, a member of Canada's National Incident Management team, and holds a Master of Science degree in Environment and Management. He has led response operations on hundreds of emergency incidents, including Canada's largest wildfire disaster.

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Kelvin Hirsch draws on a career in research, knowledge exchange, policy, science-policy integration, and research management focused mainly on the fields of wildland fire, forests and climate change, and land reclamation/restoration. Kelvin has retired from the Canadian Forest Service but remains extremely interested in interdisciplinary science – its management, application, and communication – and continues to enjoy the collaborative exploration of these topics on a casual basis.

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Mike Wotton's research focus involves developing process based models of fuel moisture exchange, fire ignition and spread that can be applied by fire management agencies throughout Canada. This work involves development of models for the Canadian Forest Service's Canadian Forest Fire Danger Rating System and the projection of climate change impacts using fire danger and fire occurrence models. Dr. Wotton works closely with fire management agencies from across Canada in the application of the results of his research into daily fire management operations.



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